# Chapter 7
# Cumulative Impacts on Wetlands

## 7.1 Reader's Guide to This Chapter

The synthesis of the scientific literature in Chapters 2, 3, and 4 has clearly established that wetlands do not function in isolation from the landscape that surrounds them. Their ability to provide certain processes and functions is affected by surrounding conditions and land uses within their contributing basins, as well as hydrologic patterns created by changing land uses.

In Chapters 5 and 6, management tools that are applied on a project-by-project basis were discussed relative to the findings of their effectiveness based on the scientific literature. The literature described in previous chapters demonstrates that project-by-project decisions cannot, by their very site-specific nature, adequately address the complexities of wetland systems as they function in a landscape context.

The findings in the scientific literature point toward the need for a broader perspective when considering management options that address, to the extent possible, the myriad of processes that determine whether wetlands remain viable on the landscape. This broader perspective is the subject of this chapter.

### 7.1.1 Chapter Contents

Major sections of this chapter and the topics they cover include:

**Section 7.2, Introduction and Background on Wetland Loss and Cumulative Impacts** describes wetland loss in Washington and three studies in the Pacific Northwest that illustrate more recent loss. It describes cumulative impacts and provides an analogy.

**Section 7.3, Implications of Current Management Practices for Cumulative Impacts** describes how the current wetland management approach of addressing resources parcel by parcel, with variation between jurisdictions, can lead to inadequate protection of wetlands.

**Sections 7.4, Cumulative Impacts Are Difficult to Assess** discusses some reasons given by researchers for the difficulty in assessing cumulative impacts.

**Section 7.5 Assessing and Planning for Cumulative Impacts** summarizes the recommendations by researchers for ways to manage aquatic resources on a landscape level rather than case by case. Watershed planning, assessment and selection of restoration sites, floodplain restoration, and other topics are discussed.

**Section 7.6, Chapter Summary and Conclusions** ties together the major concepts presented in the chapter.

### 7.1.2 Where to Find Summary Information and Conclusions

There are two brief summaries of the major points resulting from the literature review in a bullet list format. The first covers those sections which precede it, while the second is a summary of the section in which it is located. The reader is encouraged to remember that a review of all sections preceding the summary is necessary for an in-depth understanding of the topic.

For summaries of the information presented in this chapter, see the following sections:

- Section 7.4.1
- Section 7.5.3

In addition, Section 7.6 provides a summary and conclusions about the overarching themes gleaned from the literature and presented in this chapter.

### 7.1.3 Data Sources

There is adequate literature on cumulative impacts related to broad landscape-scale processes and much of it is recent. Not all of the literature is specific to wetlands. However, the implications of cumulative impacts are not wetland specific. Research has been conducted regarding the consequences of the permitting processes, as well as from the perspective of ecological systems (i.e., habitat loss, fragmentation, metapopulations, and remnant patch dynamics). Much of the literature is focused on urbanization and forest practices, with less information available on agricultural practices as they relate to cumulative effects.

## 7.2 Introduction and Background on Wetland Loss and Cumulative Impacts

In the 200-year period previous to the late 1980s the state lost an estimated 31% of its 135 million acres (55 million ha) of wetlands (Dahl 1990). In addition, changes have occurred in all types of natural resources, including forests, shrub and steppe communities, and aquatic resources including wetlands. Increasing population and decisions about land uses in the state have resulted in human activities such as diking, draining, and agricultural practices impacting wetlands, in addition to the direct loss of wetlands (Department of Natural Resources 1998).

No more current data are available for freshwater wetland losses in Washington. However, on the national level, the loss of wetlands has not stopped, according to a report released by the National Research Council (1995). The U.S. Environmental Protection Agency states that although wetland loss rates are slowing, the United States continues to lose approximately 70,000 to 90,000 acres (28,300 to 36,400 ha) of wetlands on non-federal, rural lands each year (U.S. Environmental Protection Agency 2002).

Three studies in the Pacific Northwest illustrate that the loss of wetlands continues in this region:

- Bell (2002) studied sphagnum-dominated peatlands that were originally mapped by Rigg in the early 1950s in King County. Bell found a 69% loss of these wetlands since 1958. Of 26 sites, six remained relatively undisturbed. Eight showed a decline in acreage and quality of plant communities. Five wetlands are now highly disturbed with no sphagnum moss present. The remaining seven wetlands were either drained or filled. Of the 406 acres (162 ha) present in 1958, only 125 acres (50 ha) remain today. The losses were due to agricultural conversion, development, and peat mining.

- A study of recent losses of wetlands within the Willamette Valley, Oregon, found that from 1981/1982 to 1994 there was a loss of approximately 9,500 acres (3,800 ha) of wetlands, representing approximately a 2.1% loss of wetlands within the Willamette Valley study area. They found that 70% of the loss was attributable to agriculture, 6% was associated with the impacts of urbanization, and 24% was attributable to other unidentified causes. (Bernert et al. 1999)

- A study conducted by Holland et al. (1995) in the greater Portland, Oregon, area found that 40% of the wetlands identified in the National Wetland Inventory of 1981/1982 were missing in 1992. They attributed most of the loss to the impacts of urbanization, yet they still attributed 31% of the losses to agricultural conversion. One conclusion of their study was that small, often isolated wetlands were lost due to decisions regarding single-project permits that did not take into account the overall pattern of wetland loss.

Direct loss of wetland acreage and impacts to wetland functions relating to single permits result in cumulative impacts that extend beyond individual wetlands. Johnston (1994) notes that wetlands, even physically isolated ones, are not isolated from other aquatic resources when viewed in a landscape context. Water and many organisms move freely through the landscape, so that impacts to one wetland can affect other wetlands and terrestrial habitats.

Cumulative impacts have been described by Hemond and Benoit (1988) as follows:

> *Wetlands are frequently subject to multiple impacts over time and/or space; the effects of such multiple impacts may be simply additive, or the total effect*

> *may be more severe than the sum of the effects of the individual impacts alone. Cumulative impact as used here refers to multiple impacts whose effects on the wetland cannot be predicted by simply adding the effects of all the individual impacts.*

In addition to the direct filling, draining, and altering of wetlands, less direct effects on wetlands can still result in cumulative impacts. These effects have been discussed in previous chapters and are caused by changes in land use in a wetland and its surrounding area. Wetlands and the functions they provide have been affected in terms of the distance between wetlands, the connectivity of habitat between them, and their location, distribution, and position within watersheds. As described in other chapters of this document, this affects the dispersal of animals and plants between wetlands and the water quality, flood attenuation, and hydrologic processes wetlands can provide.

**Cumulative effects of decisions made project-by-project: An analogy**

Understanding the implication of managing wetlands and other aquatic resources at a landscape level, rather than a project-by-project level, may seem abstract given the complexity of how ecosystems function in the landscape. The following analogy is offered to provide an alternative description of cumulative effects. Credit for the following analogy was given to Gosselink and Lee by Preston and Bedford (1988):

> *Imagine a Renaissance mosaic of a mother and child, composed of beautiful tiles of various shapes and colors. As it has aged the mosaic has begun to lose tiles. As managers responsible for the mosaic, we have to determine which of the tiles to preserve and reinforce, which to attempt to restore, and which we will allow to be further damaged or even destroyed. Our objective is to attempt to preserve the highest value for the mosaic. Using a tile-by-tile decision methodology (the project-by-project impacts assessment), each tile would be assessed separately and individually for its intrinsic value. Each decision for a tile would not consider the other nearby tiles, nor even how the tiles fit into the whole image. This strategy would very likely not preserve the image of the mother and child. Yet, it is the image that gives the mosaic its inherent value, not the sum of the individual tiles. If one is to preserve the value of the image, then one needs to be able to determine the relative significance of each individual tile relative to each other tile and to the image as a whole.*

The following section describes how the current approach to managing wetlands can lead to cumulative impacts, discusses the need to consider cumulative impacts when making decisions about wetlands, and identifies some reasons given by researchers for the difficulty in assessing cumulative impacts.

# 7.3 Implications of Current Management Practices for Cumulative Impacts

Some of the causes of cumulative impacts on wetlands stem from how wetlands are regulated in Washington State, and how case-specific decisions are made for each individual project. These findings relative to regulations at the local (city or county) level are discussed further below.

Decisions about wetland protection and management in Washington State occur at the federal, state, and local levels. While federal and state agencies regulate many direct impacts to most wetlands, they do not regulate land uses outside of wetlands and, thus, cannot protect many of the wetland functions. The primary responsibility for protecting wetland functions lies with local governments. In Washington State, local jurisdictions have zoning codes that establish the regulatory framework for wetlands. Thus each city or county has its own independent wetland regulations. In an effort to encourage concurrency between adjacent jurisdictions for wetland planning and implementation, the state legislature passed the Growth Management Act (GMA) in 1992.

The GMA encouraged consistency between adjacent jurisdictions to reduce confusion and conflicts between regulatory standards from one jurisdiction to the next. However, consistency has not always been achieved, and adjacent jurisdictions may have quite different regulatory standards.

On the simplest level, adjacent jurisdictions may have different management objectives for resources and distinctly different criteria and standards. For example, differences in rating systems between two contiguous jurisdictions may result in different ratings for the same large wetland complex that crosses the boundaries between the jurisdictions. Differences in ratings may result in distinctions in protection such as buffer dimensions or replacement ratios. Whether different portions of the same wetland are protected at all could vary from one local jurisdiction to the next.

As noted by Albrecht et al. (1995), delegating authority to counties and municipalities can lead to tremendous variation in land use patterns. The literature is clear that when broad-scale environmental landscape issues, like managing watersheds and ecological processes, require cross-jurisdictional cooperation and collaboration, "Jurisdictional fragmentation impedes wise environmental planning" (Albrecht et al. 1995). Thus, one source of cumulative impacts is the lack of consistent regulations from one jurisdiction to the next for ecological systems that depend upon landscape-scale processes across jurisdictional boundaries.

Although there is currently no substantial literature on the implications of different management strategies between jurisdictions, there is significant literature on the relation between case-by-case decision-making and cumulative impacts. In fact, one reason often cited for the failure of site-specific management to adequately protect aquatic resources is the inability of such an approach to address cumulative impacts (Johnston et al. 1990, U.S. Environmental Protection Agency 1999, Dale et al. 2000).

Research from many sources has clearly identified that piecemeal (case-by-case) implementation of environmental regulations is having a substantial cumulative impact because it fails to identify and account for the landscape-scale processes that create and maintain wetlands (Wissmar and Beschta 1998).

Preston and Bedford (1988) note that making project-by-project decisions fails to evaluate the project and its potential impacts within the spatial and temporal scale within which ecosystems function. They state that although making project-by-project decisions

> *. . . allows evaluation of the local impacts on resources, it does not allow evaluation of impacts of the project on these resources as a whole, of the total impact on these resources from all anthropogenic disturbances, or of secondary impacts resulting from the interaction of impacts from the project with other anthropogenic disturbances. This is true because the spatial and temporal boundaries of the analysis have not fully enclosed spatial and temporal dynamics of the environmental resources of concern and the anthropogenic activities influencing them.*

They recognize that impacts can be generated not only from project-specific actions, but also from actions that occur out of time and outside the vicinity of the activity that may be under scrutiny for a particular project.

Other scientists, such as Everard (1999), are concerned that regulating wetlands and other aquatic resources on a case-by-case basis, without considering watershed or landscape processes, creates the illusion that the resources are being protected by case-by-case management decisions. This has serious ramifications:

1. The public assumes that current land use regulations and management decisions are adequate to protect aquatic systems.

2. There is a resultant public perception that protection of aquatic resources is a continuing financial burden.

If it is assumed by the public, the decision-making bodies (councils, commissions, and/or planning boards), and the implementing staff (planners) that case-by-case permitting is adequate to protect the resources, then there is no incentive to assess or modify the existing policies or regulatory programs. One element that the current scientific research has not adequately addressed is the lack of understanding that the regulatory programs currently in place may not be effective and may be inadvertently deceiving the public regarding protection of complex resources. This is partially due to the difficulty in assessing cumulative effects.

# 7.4 Cumulative Impacts are Difficult to Assess

In the late 1980s, Bedford and Preston (1988) observed, “The incongruity between the regional scales at which wetland losses are occurring and the project-specific scale at which wetlands are regulated, and also studied, has become obvious.” They pointed out that research conducted and information generated on a wetland-by-wetland basis does not provide the data necessary to address the complexity of managing ecosystems across a landscape scale. They noted that:

> *…improving the scientific basis for regulation will not come merely from acquiring more information on more variables. It will come from recognizing that a perceptual shift in temporal, spatial, and organizational scale is overdue, the shift in scale will dictate different—not necessarily more—variables to be measured in future wetland research and considered in wetland regulation.*

However, the recommendations from the literature are consistent: Cumulative impacts should be assessed (Johnston 1994, Stein 2001). Abbruzzese et al. (1990) state that once cumulative impact assessment is conducted it "provides a context for wetland permitting." This means that when potential cumulative impacts have been analyzed and identified, then the potential implications of a proposed single action can be assessed in the context of the entire watershed, by assessing historic actions, existing conditions, and watershed configuration and functions.

Assessing cumulative impacts is challenging. The technical issues that complicate an analysis of cumulative impacts include:

- The large spatial and temporal scales involved
- The wide variety of ecological processes and interactions that are present in natural systems
- The lag times that can often separate a land use activity from resulting effects

In addition to the scale of space and time, and the complexity of ecological processes, it is also difficult to differentiate between human-caused and natural variations. It is challenging to discern cause and affect relationships when looking at ecosystems that are subject to both variations in natural processes and associated disturbances, as well as anthropogenic changes. Natural systems are in a constant state of change, responding to landscape variables that influence ecosystem processes. It is difficult in some instances for research to unravel the influence of human-caused disturbances that are embedded within natural variability.

Researchers also recognize that it is difficult to isolate cause-effect relationships in a landscape context. As mentioned previously, Johnston (1994) notes that wetlands, even physically isolated ones, are not isolated from other aquatic resources when viewed in a landscape context. Water and many organisms move freely through the landscape, so that impacts to one wetland can affect other wetlands, terrestrial habitats, and the species that depend upon them. Effects can accumulate in the following ways (Johnston 1994):

- **Time-crowded perturbations**, in which disturbances occur so close together in time that the system cannot recover in the time between.

*Example:* Reoccurring flooding that drowns vegetation that is not adapted to prolonged inundation.

- **Space-crowded perturbation**, in which disturbances are so closely spaced on the landscape that their effects are not dissipated in the distance between.

  *Example:* Construction of new highways and high-density commercial zones on both sides of a wetland, resulting in increased noise, lighting, and human presence.

- **Synergisms**, the interaction of disturbances to produce effects that are qualitatively and quantitatively different from the individual disturbances.

  *Example:* Stormwater discharge into a wetland that causes both a change in the water level fluctuations and an increase in excess nutrients and toxics entering the wetland.

- **Nibbling**, disturbances that produce effects by small incremental changes.

  *Example:* A 50-foot buffer around a wetland within a residential development in which the homeowners encroach on the buffer over time by expanding their lawns.

- **Indirect effects**, in which disturbances produce effects remote in time or space from the original disturbance.

  *Example:* Conversion of the upper portion of a watershed into high-density impervious areas, resulting in interception of shallow groundwater recharge, increased surface water volumes, and greater rates of discharge into the natural drainage system.

From Johnston's (1994) findings one can conclude that impacts to wetlands cannot be determined by looking at one point in time or viewing impacts isolated from other actions that have occurred within the landscape historically or may occur in the future.

Inter-jurisdictional decision-making adds another layer of complexity to the issue of cumulative effects. Permit decisions made by one jurisdiction within a watershed can add to the consequences of another jurisdiction's decisions within the same watershed.

The authors cited are in agreement that the consequences of cumulative impacts are easier to assess than the causes. Small incremental changes may not singly be the cause of a major change—it is the synergistic and compounding consequences that may result in the observable cumulative impacts.

Therefore, evaluation of cumulative effects requires a non-traditional way of evaluating resource impacts. As noted by Preston and Bedford (1988):

> *Cumulative effects on freshwater wetland ecosystems are more tangible than any scientific basis for measuring these effects. The notion that individually insignificant actions can produce major change through the accumulation of effects is compelling enough to have influenced federal legislation, initiated court action, and produced international meetings. Yet constraints remain more obvious than any specified approach or method for implementing this idea in natural resource regulation and management.*

"Cumulative effects analysis requires a non-traditional approach to information by recognizing that patterns are more important than details, an interdisciplinary focus is more important than a mono-disciplinary foci, and large areas are more than the sum of their parts and so must be evaluated as a unit" (Reid 1998).

### 7.4.1 Summary of Key Points

- In Washington State, decisions about wetland protection and management occur at the federal, state, and local levels. Therefore, the same wetland may be subject to a variety of policies and regulatory standards. Permit decisions are most often made on a case-by-case basis. Decisions made on a case-by-case basis by jurisdictions with differing standards can result in cumulative effects and loss of wetland function across the landscape.
- Cumulative effects are difficult to assess because of the large spatial and temporal scales involved, the wide variety of processes and interactions, and the lag times that can often separate a land use activity from resulting effects. Therefore, evaluation of cumulative effects requires a non-traditional way of evaluating resource impacts.
- The causes of cumulative effects are not limited to the policies and regulations of a single agency but can also be caused by the compounding effects of multiple agencies making land use decisions in isolation and without comprehension of the implications of accumulated effects.

## 7.5 Assessing and Planning for Cumulative Impacts

Despite the difficulties associated with assessing cumulative impacts, several researchers have attempted to create methods for analyzing them on a landscape scale that incorporates historic, present, and proposed actions. In synthesizing the scientific information for assessing cumulative effects, Bedford and Preston (1988) identified that there was sufficient knowledge to prepare quantitative models for hydrology and water quality. Brinson (1988) called for assessing the location and condition of wetlands within a watershed or landscape as one means to ensure that long-term cumulative effects on water quality are addressed. Brinson notes that under normal conditions, wetlands tend to function as sinks for nutrients, metals, and organic litter, with modest accretion rates over time. However, when the wetland hydroperiod is changed, wetlands can become significant exporters of accumulated nutrients, toxics, or sediments through subsidence and export, a decrease in performance of water quality functions due to structural change in the wetland, thereby having potential adverse effects on aquatic systems downstream. This information can be integrated into a landscape-scale management or prioritization plan.

Stakhiv (1988) states that cumulative impact analysis cannot be limited to the effects on ecological processes. The author provides model formulas for quantifying the consequences of project-by-project decisions by incorporating the human social and economic consequences as well. He cautions that analysis of cumulative impacts needs this broader perspective to create and maintain validity in the regulatory context.

All of the preceding authors present strong science-based rationales for analyzing existing conditions at a watershed scale or a landscape scale that may be smaller than an entire basin. However, most of these authors do not address the difficulties of conducting landscape-scale assessments, or the inherent political challenges of conducting such assessments across jurisdictional boundaries.

## 7.5.1 Planning Approaches Using a Landscape Perspective

Advanced planning is required to minimize cumulative effects and restore systems that have already been impacted. This section provides examples of approaches and planning efforts that incorporate a landscape approach, whereas the next section presents examples of restoration efforts. Much of the available literature on watershed or landscape planning is in the context of streams and rivers rather than wetlands, with the exception of the West Eugene Plan. However, the findings and conclusions of that literature were determined to be relevant to wetland planning.

Stein (2001) presents an approach to planning based on placing aquatic systems in the context of the greater landscape, including the floodplain, riparian corridors, and connectivity of processes. Stein's recommendations include identifying areas that provide functions at a higher level early, in order to preserve them at the "cost" of allowing the loss of areas with lower levels of function. It is not possible to attempt such a trade-off in a situation where projects are analyzed on a case-by-case basis and no landscape-level analysis has been conducted.

It may be hypothesized, however, that this approach may result in the loss of wetlands whose restoration might be important for improving processes and functions at the landscape level. Some degraded wetlands that are currently not performing functions well may be in a critical position in the landscape and are important locations for restoring process throughout a watershed. For example, there are currently many degraded wetlands behind dikes at the mouth of the Snohomish River. These wetlands, however, can easily be restored to provide significant habitat for salmonids (City of Everett 1997). If these wetlands are lost, the potential for restoring salmonid habitat in the watershed is reduced.

Stein also calls for understanding past decisions that have been made and the consequences of those decisions relative to the ecological processes that continue within the landscape scale. That is only possible with a landscape-scale analysis prior to making decisions regarding single projects.

Stein recommends:

- Anticipating project-specific impacts in the context of past actions and the landscape-level processes in the project area
- Maintaining floodplain integrity by considering the impacts to the entire riparian zone during the planning process and permit review
- Using wider, more natural riparian corridors to stabilize banks, minimize erosion, and reduce flow velocities
- Creating permit and mitigation requirements to reflect the magnitude and permanence of the impact
- Preserving portions of the landscape that have higher function or are more valued as compensation for loss of lower functioning portions

Another approach recommended by Schueler and Holland (2000) involves applying zoning at a watershed scale. They propose a classification scheme for streams in urban and urbanizing areas with specific resource objectives for each stream and subwatershed. "Specific policies and practices [that address elements such as] impervious cover limits, stormwater practices, and buffers are then instituted to meet the stream resource objective, and these practices directly applied to future development projects."

Schueler and Holland conclude that the process of planning at the landscape scale "forces local governments to make hard choices about which streams will be fully protected and which will become at least partially degraded. Some environmentalist and regulators will be justifiably concerned about the streams whose quality is explicitly sacrificed under this scheme." They conclude that when a jurisdiction looks at the entire aquatic system within a watershed, rather than the permit-by-permit approach, the jurisdiction can generate more accurate information and make more informed choices about how the entire aquatic system works, recognizing the consequences of difficult choices up front.

They acknowledge that this will result in further impacting some lower priority resources while allowing land use changes to occur in a more informed manner. Their suggested approach, as with that of Stein (2001), is based on the premise of identifying and assessing an entire watershed and/or landscape in order to understand the processes that are linked, and prioritize choices about resource protection. This approach also implies that decision-makers and the public are more thoroughly informed as to the consequences of the choices that are made.

The West Eugene Wetlands Special Areas Study or "West Eugene Plan," prepared for West Eugene, Oregon, is a well known and documented, multi-objective, watershed-based planning effort. Gordon (1995) describes the plan as being implemented at the local level to address issues of wetland and wildlife habitat protection, flood control, stormwater quality treatment, recreation and education, as well as research. He notes that, "Landscape approaches allow systems to be viewed from a natural and human perspective. A comprehensive approach allows environmental and urban development considerations to be viewed together."

The West Eugene Plan assessed all the resources within a planning area covering 16 square miles where there is a large concentration of wetlands. It considered multiple variables including economic considerations, infrastructure, and restoration potential. Through an intense collaborative process the plan has been adopted and implemented by the city. It provides a model for how prioritized, watershed-based planning can be adopted and implemented in an urban watershed.

Weber and Wolf (2000) describe a program in the State of Maryland where the state and local agencies are working together on a landscape scale to create an interconnected corridor network of prioritized critical habitats and linkages based on ecological parameters and threat parameters. This statewide process, the Green Infrastructure Assessment (GIA), is based on identifying hubs and corridors using a geographic information system (GIS). It identifies hubs on two tiers: statewide significant hubs must be 2,000 acres (809 ha), and hubs of local concern are 500 to 2,000 acres (202 to 809 ha). Corridors link the statewide or local hubs and include "nodes," which can be patches of interior forest, wetlands, habitat areas for identified sensitive species, or other protected areas located along the corridors. Although this particular program is centered on "green infrastructure" (not just aquatic resources), their findings are clearly germane to any landscape-scale management or protection program.

Their approach was based on the following:

- The role of a given place as part of a larger interconnected ecological system
- The value of integrating the interests of multiple resources into a single framework
- The importance of considering the integrity of natural resources/ecosystems in the context of existing and potential human impacts to the landscape
- The importance of regional (i.e., inter-jurisdictional) coordination of local planning
- The need for a regional element to a strategy for the conservation of biodiversity

This approach recognizes the need to incorporate coordination with regional and local planning efforts along with existing and potential human impacts. It is a pragmatic approach that incorporates input from all levels, recognizes that humans are a part of the problem and the solution, and realizes that the solution must reflect regional and local planning and implementation frameworks.

## 7.5.2 Landscape-Scale Planning and Restoration

Planning for restoration within a watershed also requires an analysis of cumulative effects and landscape-scale processes. The literature contains consistent recommendations for incorporating cumulative impact analysis into the process of undertaking watershed restoration actions.

In writing about restoration of riparian ecosystems, Wissmar and Beschta (1998) make it clear that the landscape context, including all the historic, ongoing, and future influences on an ecosystem, must be considered when attempting restoration actions. This same broad perspective is required in the beginning of the planning process. If the goal is to maintain sustainable ecosystems, then one has to identify and understand how they function within the landscape and what elements must be accounted for to ensure long-term viability.

Bedford (1999) argues that one should conduct a cumulative impact analysis for the region when considering wetland restoration activities in a watershed. The analysis should not be focused on the amount of historic wetland loss but rather on the concept of "templates for wetland development" that control the "hydrologic variables and hydrologically influenced chemical variables" that form and maintain wetlands. This is necessary in order to make informed decisions about the suitability of specific restoration actions in particular landscape positions.

Bedford goes on to state:

> *. . . wetland restoration has the potential to increase wetland diversity as well as wetland area but only if those planning restorations do so within the context of cumulative effects analysis that considers landscape patterns of loss and degradation and landscape controls of wetland development. A cumulative effects analysis draws attention to wetlands as landscape elements.*

Smith and Jones (1997) describe the need to take a landscape approach to restoration and protection of riparian communities with an understanding of the relationships between geomorphology, hydrology, and vegetation. Their paper outlines a two-stage approach to prioritizing restoration at two different scales, the reach scale and the site scale. This approach is again based on the concept that landscape processes beyond the site scale are vital to design and decision-making.

The Drayton Harbor, Washington, sub-basin analysis (Stanley et al. 2003) is an example of a landscape approach that identifies restorable wetland sites based on recovery of watershed processes. This analysis targeted wetlands for restoration based on their potential for restoring functions, structure, and processes that address environmental problems at the landscape scale. Using this approach, deficient functions within a sub-watershed can be addressed such as water quality improvement, flood attenuation, habitat losses, etc. This method is a flexible tool for tailoring wetland restoration choices to the most desirable location for achieving the greatest benefits to functions.

Almendinger (1999) also discusses a method of prioritizing wetland restoration to achieve water quality improvement in agricultural basins, with an example in the Minnesota River Basin. The author categorizes three factors that affect water quality improvement in wetlands: loading factors, path factors, and process factors. These factors affect the amount, timing, and chemical alteration of suspended sediments and nutrients.

Three key questions should be asked about site selection factors that will affect the wetland's ability to improve water quality:

- Is the site in an area with known water quality problems? (problem effectiveness)
- Is the site likely to improve water quality more or less than other sites? (function effectiveness)
- Does the site fit within an overall research plan to gain information on how wetlands improve water quality? (information effectiveness)

In addition to water quality benefits, Almendinger (1999) discusses ways to integrate other benefits of restoration, including wildlife habitat and flood attenuation. The author concludes:

> *Re-conversion of productive agricultural land to wetland will be expensive, but should be considered in light of the original landscape, and the cost of doing nothing to change the present landscape. Pimentel et al. (1995) argue that the cost due to soil erosion under current practices is about five times the cost needed to implement soil conserving practices such as upland BMP's and wetland restoration. In the long run, wetland restoration may be far less expensive than doing nothing.*

This guidance is applicable to restoration efforts at the landscape scale across the country.

A few authors focused on planning for restoration of floodplains, riparian areas, and associated aquatic habitats using a landscape approach. Most large river floodplains in the Pacific Northwest once supported extensive wetland systems. Years of agricultural conversion by diking, dredging, port development, and urbanization have resulted in significant loss of wetlands in the lower floodplains, 90 to 99% in most systems (Bortelson et al. 1980). Thus, the restoration of floodplain and riparian wetlands offers an opportunity to address these losses as well as other issues.

Coulton et al. (1996) studied the Willamette River, Oregon, to assist the U.S. Army Corps of Engineers in modifying current practices toward an integrated long-range plan for restoring the flood capacity of the watershed, its aquatic and riparian habitat, water quality, and threatened and endangered species. The report identified several indirect benefits from restoring former wetlands in the floodplain:

- Increasing seasonal water availability
- Reducing downstream sediment

- Improving water quality

The report recommends using a hydrology database and a geomorphology model for the river as part of the method to prioritize and select sites for restoration. A synthesis of the literature on the Willamette River specifically, and watershed and stream restoration generally (particularly in urban areas), is available from Portland Metro (2002).

Goodwin et al. (1997) found over 400 papers published between 1970 and 1995 on the subject of riparian restoration. They recommend looking at processes within the watershed and responding to overarching problems—not local symptoms—when approaching riparian restoration. The principles presented in their paper are equally applicable to restoration of riparian wetlands. They suggest asking the following regarding the causes of degradation:

- Is the disturbance local or does it originate outside the degraded system?
- Is the disturbance ongoing or can it be eliminated?
- Will the system recover on its own if the disturbance is removed?

Hawkins et al. (1997) found that planning restoration and selecting sites in riparian areas (for compensatory mitigation or on a voluntary basis) must include an evaluation of the vulnerability of the sites to disturbances caused in other locations in the landscape. They argue that it is not enough to select sites that have the highest potential for supporting wetland functions: It is necessary to couple the selection criteria with an evaluation of the vulnerability of different sites to natural and anthropogenic disturbances. They found that flooding damage to riparian vegetation was related to the amount of riparian vegetation present in the floodplain and the amount of urban surface in the upstream watershed. They conclude:

> *. . . sites near existing large areas of intact riparian vegetation and away from urban development will have the highest potential for successful long-term restoration . . . The key to selecting sites with the greatest overall potential for successful restoration is to properly weigh different site selection criteria in context to overall restoration objectives (e.g., what riparian values and functions are most desirable).*

The need to incorporate the degree of disturbance in the watershed is equally relevant to the Pacific Northwest and to compensatory mitigation. A case in point is a wetland that was created to compensate for the impacts of the Nisqually Fish Hatchery on Clear Creek. Soon after the riverine site met its regulatory performance standards, it was damaged during a flood event. The 1996 flood deposited up to 5 feet (1.5 m) of alluvial material in the outflow channel constructed for the created wetland. The material buried vegetation and separated the wetland from the river, converting it to a depressional wetland (Wiltermood, personal communication). Caution is recommended when conducting wetland projects in highly dynamic landscape settings.

### 7.5.3 Summary of Key Points

- Project-by-project permits do not address the complexities of wetland and ecosystem processes that the scientific literature has clearly identified. Such case-by-case decision-making results in cumulative impacts and jeopardizes the long-term sustainability of aquatic resources.
- Researchers have suggested assessment methods and planning approaches for use in addressing cumulative impacts to aquatic resources. Elements include considering an entire watershed, recognizing past land use patterns and thereby anticipating project-specific actions, preserving those portions of the landscape with higher or more valuable functions as compensation for loss of lower functioning portions, and prioritizing the resources or goals and objectives as a basis for the management plan. Some authors have included social and economic considerations within the formulation of a watershed or landscape plan.
- The literature recommends a watershed approach for the management and restoration of aquatic communities. Researchers recognize the need for an analysis of cumulative effects (the historic, ongoing, and future impacts on an ecosystem) and landscape-scale process (including geomorphology, hydrology, vegetation, etc). The most desirable locations for restoration can then be chosen in order to achieve the greatest benefits.
- It is not enough to select restoration sites that have the highest potential for supporting wetland functions. The selection criteria need to be coupled with an evaluation of the vulnerability of different sites to both natural and human disturbances within a landscape context. This is the only way to ensure long-term success of the restoration.
- Several landscape-scale planning efforts have been implemented in the Pacific Northwest region. These provide local models for understanding approaches, consequences, and strategies for implementation.

## 7.6 Chapter Summary and Conclusions

The majority of wetland management decisions in Washington State are based on case-by-case actions related to specific projects, without any opportunity to consider landscape-scale processes or consequences. This pattern is a result of the current structure of programs at local, state, and federal regulatory agencies. The results of the research on case-by-case permitting processes are clear: There are consistent wetland losses regionally and statewide.

In spite of regulatory programs at federal, state, and local levels, wetland impacts continue to occur. These impacts are often the result of cumulative and synergistic impacts across the landscape.

The benefit and anticipated consequences of managing natural resources within a landscape context are well documented. In the case of wetland resources, a landscape-scale management program has not been implemented in Washington State. However, examples from Oregon and elsewhere in the nation provide approaches that may help address cumulative impacts in Washington. The literature reviewed for this synthesis did not focus on the reasons for the lack of landscape-scale strategies, but some impediments can be assumed:

- Costs of analysis, inventories, assessments, and rankings
- Costs of implementing a landscape-scale program relative to existing project-driven programs that are often funded by applicant fees
- Inconsistent mandates driving the agendas and priorities of regulatory agencies
- Lack of examples of successful tools for interagency collaboration and implementation
- Lack of awareness and understanding of the ecological consequences of existing regulatory programs by the public and the staff of implementing agencies
- Lack of support for local jurisdictions to tackle the process of identifying and prioritizing aquatic resources for long-term protection and/or potential alteration

Volume 2 of this two-volume document will build on the foundation of scientific information in this synthesis to construct options and recommendations for the protection and management of wetlands and their functions at the site and landscape scales. The production of Volume 2 will begin during the review period for Volume 1.